



# LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA5 | Northolt Corridor

**Water resources assessment (WR-002-005)**

Water resources

November 2013

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# Department for Transport

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# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Structure of the water resources and flood risk assessment appendices	1
1.2	Study area	1
<b>2</b>	<b>Stakeholder engagement</b>	<b>3</b>
<b>3</b>	<b>Baseline data</b>	<b>4</b>
3.1	General	4
3.2	Surface water	4
3.3	Groundwater	9
3.4	Surface water/groundwater interaction	14
3.5	Water dependent habitats	15
<b>4</b>	<b>Site specific surface water assessment</b>	<b>16</b>
4.1	Surface water	16
4.2	Detailed assessments	20
<b>5</b>	<b>Site specific groundwater assessment</b>	<b>21</b>
5.1	Summary of assessment	21
5.2	Detailed assessment	24
<b>6</b>	<b>References</b>	<b>27</b>

## List of figures

Figure 1: Schematic geological cross-section for CFA5	11
Figure 2: Groundwater elevation contours for this study area and the surrounding area	12
Figure 3: Illustration of abstraction locations relative to the route and geology	25

## List of tables

Table 1: Surface water features within 500m of the route in the study area	5
Table 2: Surface water discharge consents	9
Table 3: Licensed groundwater abstractions	13
Table 4: Discharge consents to groundwater	14
Table 5: Surface water/groundwater interaction	14
Table 6: Summary of potential impacts to surface water	17
Table 7: Summary of potential impacts to groundwater receptors	22
Table 8: List of private groundwater abstractions	24

# 1 Introduction

## 1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 The water resources and flood risk assessment appendices comprise several parts. The first of these is a route-wide appendix (Volume 5: Appendix WR-001-000).
- 1.1.2 Two specific appendices for each community forum area (CFA) are also provided. For the Northolt Corridor area (CFA5) these are:
  - a water resources assessment (i.e. this appendix); and
  - a flood risk assessment (Volume 5: Appendix WR-003-005)
- 1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

## 1.2 Study area

- 1.2.1 The study area covers an 8.7km section of the Proposed Scheme in the London Borough of Ealing (LBE). The northern tunnel passes through the London Borough of Brent (LBB) to the west of Hanger Lane, whilst the London Borough of Harrow (LBHa) lies adjacent to the route to the north. The route extends from Park Royal Road Bridge in the east to a point near Rabournmead Drive in the west.
- 1.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement has been used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this spatial scope is defined as the study area.
- 1.2.3 The main environmental features of relevance to the water resources and flood risk assessment include the:
  - Grand Union Canal (GUC) (Paddington Branch);
  - River Brent;
  - Chalk Principal aquifer;
  - Lambeth Group Secondary A aquifer;
  - Thanet Sand Formation Secondary A aquifer; and
  - eight licensed groundwater abstractions.
- 1.2.4 Key environmental issues relating to water resources include:

- potential impacts on groundwater flow to local private abstractions; and
- potential temporary impacts on groundwater quality as a result of construction activities associated with tunnelling.

1.2.5 Where a residual effect or mitigation for water resources impacts has a significant effect on ecology this is discussed further in the Volume 2, Northholt Corridor (CFA Report 5), Section 7.

## 2 Stakeholder engagement

2.1.1 Consultation with the following stakeholders has been undertaken to inform the water resources assessment:

- the Environment Agency;
- the London Boroughs of Brent, Ealing and Harrow;
- Ealing Golf Club and;
- the Canal & River Trust (formerly British Waterways) with regard to the GUC (Paddington Branch).

## 3 Baseline data

### 3.1 General

- 3.1.1 The following sub-sections provide a current description of water resources within the study area including surface water and groundwater features.
- 3.1.2 Water bodies within the study area include the River Brent and the GUC (Paddington Branch) as well as a number of un-named drains and ponds. The catchments fall within the Thames River Basin District as defined under the Water Framework Directive<sup>1</sup> (WFD) and are covered by the associated River Basin Management Plan (RBMP)<sup>2</sup>.

### 3.2 Surface water

- 3.2.1 All surface water features within 500m of the route are presented in Table 1.
- 3.2.2 The current surface water baseline is shown in Volume 5, Water Resources and Flood Risk Assessment Map Book, Maps WR-01-005 and WR-01-006. Where a water feature in Table 1 has been given a map reference it appears on one of these maps. The map reference is in one of two forms. If the feature has a specific reference number then this is provided (e.g. a surface water crossing will be referenced as SWC-CFA05-01). If the feature has no specific reference its location on a specific map is provided (e.g. WR-01-005, D6) where D6 is a grid reference using the map specific grid.
- 3.2.3 The surface water features are based on the Environment Agency's Detailed River Network (DRN) with the addition of water bodies noted on the Ordnance Survey's (OS) 'OS VectorMapDistrict'. This data set provides only an indicative straight line route for watercourses that have been culverted for long distances beneath urban areas.

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<sup>1</sup> Water Framework Directive - Directive 200/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Strasbourg, European Parliament and European Council

<sup>2</sup> Environment Agency (2009) River Basin Management Plan, Thames River Basin District

Table 1: Surface water features within 500m of the route in the study area

Water feature	Location description (Volume 5 Water Resources and Flood Risk Map Book map reference)	Watercourse classification <sup>3</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>4</sup>	Q95 <sup>5</sup> (m <sup>3</sup> /s)	Catchment area at crossing (km <sup>2</sup> )	Notes
Park Royal several ponds and drains	Located at Park Royal north of the route. (CFA05-P01)	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	No obvious connection to any other surface water body.
Hanger Hill Park drains	Located south of the route within Hanger Hill Park. (WR-01-005, E6)	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	Small drains within a golf course. No obvious connection to any other surface water body.
River Brent	The route will pass in tunnel beneath the River Brent near Manhatten Business Park, Alperton. (SWC-CFA05-01)	Main river	River Brent (below Silk Stream down to the Thames). GB106039023590 Poor	Good potential	High	0.161	138	The watercourse is heavily modified. It flows approximately north to south and joins the GUC before discharging to the River Thames.
Neville Road drain	Located near Perivale Village and Neville Road within allotments approximately 300m south of the route. (WR-01-005, D6)	Ordinary watercourse	No status class in RBMP – assumed status  Poor	No status class in RBMP – assumed status  Good potential	Moderate	Not applicable	Not applicable	Appears to be connected to the River Brent.

<sup>3</sup> Water-feature classifications: Section 113 of the Water Resources Act 1991 defines a main river as a watercourse that is shown as such on a main river map. Section 72 of the Land Drainage Act 1991 defines an ordinary watercourse as 'a watercourse that is not part of a main river'. Section 221 of the Water Resources Act 1991 defines a watercourse as including 'all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. Main rivers are larger rivers and streams designated by Defra on the main river map and are regulated by the Environment Agency

<sup>4</sup> For examples of receptor value, see Table 43 in the Scope and Methodology Report (SMR) Addendum, Volume 5: Appendix CT-001-000/2.

<sup>5</sup> Derived from National River Flow Archive(NRFA) data and catchment areas calculated using the Flood Estimation Handbook (FEH) - Centre for Ecology and Hydrology, (2009) Flood Estimation Handbook (FEH) CD-Rom Version 3.0. Q95 is the flow which is exceeded for 95% of the time (i.e. it is a low flow and the river will only have flows less than this for 5% of the time).

Appendix WR-002-005

Water feature	Location description (Volume 5 Water Resources and Flood Risk Map Book map reference)	Watercourse classification <sup>3</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>4</sup>	Q95 <sup>5</sup> (m <sup>3</sup> /s)	Catchment area at crossing (km <sup>2</sup> )	Notes
Four small ponds and several drains at Ealing Golf Course	Located within Ealing Golf Course south of the route. (CFA05-Po2)	Ordinary watercourse (drains) Not assessed (ponds)	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good potential	Moderate	Not applicable	Not applicable	Numerous small drains and ponds most of which appear to be connected to the River Brent.
Perivale Industrial Park drain	The route will pass in tunnel under Perivale Park Brook near Perivale Industrial Park, Perivale. ( SWC-CFA05-02)	Ordinary watercourse	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good potential	Moderate	0.0007	0.54	It is likely, based on Ordnance Survey (OS) mapping, that the drain flows westwards and passes under Ealing Central Sports Ground before flowing southwards under the A40 and joining the River Brent near Stockdove Way.
Perivale Bridge drains	Located near Perivale Bridge, south of the route. (WR-01-005, C7)	Ordinary watercourse	No status class in RBMP – assumed status Poor	No status class in RBMP – assumed status Good potential	Moderate	Not applicable	Not applicable	Small drains which discharge into the River Brent.

Water feature	Location description (Volume 5 Water Resources and Flood Risk Map Book map reference)	Watercourse classification <sup>3</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>4</sup>	Q95 <sup>5</sup> (m <sup>3</sup> /s)	Catchment area at crossing (km <sup>2</sup> )	Notes
Horsenden Hill drains, culvert and five ponds	Horsenden Hill Recreation Ground, north of the route and GUC.  (CFA05-P03)	Ordinary watercourse (drains)  Ponds (not assessed)	No status class in RBMP – assumed status  Moderate	No status class in RBMP – assumed status  Good potential	Moderate	Not applicable	Not applicable	The drains most likely discharge into the GUC (Paddington Branch).
Greenford Road drain (Costons Brook)	The route will pass in tunnel under the culverted Costons Brook near Greenford Road (A4127) and Rockware Avenue, Northolt.  ( SWC-CFA05-03)	Ordinary watercourse	No status class in RBMP – assumed status  Poor	No status class in RBMP – assumed status  Good potential	Moderate	0.003	2.57	This drain is in an extended culvert with flow from north to south. The crossing location is not precisely defined in the DRN. The drain continues south through both surface water drains and culverts before entering the River Brent at Perivale Park Golf Course.
GUC dock and two drains	A dock connected to and south of the GUC at Ockham Drive, north of the route.  Drains located near Rothesay Avenue and Carr Road draining towards the GUC, north of the route.  (WR-01-005, H5)	Artificial/ordinary watercourse	No status class in RBMP – assumed status  Moderate	No status class in RBMP – assumed status  Good potential	High/moderate	Not applicable	Not applicable	The course of the drain is partly in culverts. The drain discharges into the GUC.  The dock is connected to the GUC.
GUC (Paddington)	The route will pass beneath the Paddington	Artificial	GUC, Uxbridge to Hanwell Locks, Slough	Good potential	High	Not	Not	Located north of, and approximately parallel to,

Appendix WR-002-005

Water feature	Location description (Volume 5 Water Resources and Flood Risk Map Book map reference)	Watercourse classification <sup>3</sup>	WFD water body and current overall status	WFD status objective (by 2027 as in RBMP)	Receptor value <sup>4</sup>	Q95 <sup>5</sup> (m <sup>3</sup> /s)	Catchment area at crossing (km <sup>2</sup> )	Notes
Branch)	Branch of the GUC near the Kelvin Industrial Estate, Northolt. ( SWC-CFA05-04)		Arm, Paddington Arm. GB70610078. Moderate			applicable	applicable	the route from the CFA4/CFA5 boundary to the route crossing point at Kelvin Industrial Estate, Northolt. The canal arm then runs in an approximately southerly direction to join the GUC.
Belvue Park unnamed watercourse	Unnamed river flowing into an Extended Culvert in Belvue Park, Northolt, south of the route. (WR-01-005, G7)	Ordinary watercourse	No status class in RBMP – assumed status  Poor	No status class in RBMP – assumed status  Good potential	Moderate	Not applicable	Not applicable	Secondary river which flows south into an extended culvert near Belvue School. The culvert flows under the GUC through a few surface water drains, before entering the River Brent.
Five small ponds at Lord Halsbury Memorial Playing Fields	Lord Halsbury Memorial Playing Fields, Northolt, located south of the route. (CFA05-P05)	Not applicable	Not applicable	Not applicable	Moderate	Not applicable	Not applicable	

3.2.4 There are no licensed surface water abstractions within 500m of the Proposed Scheme in the study area<sup>6</sup>. There is the potential for unlicensed abstractions to exist that have not been identified, as a licence is not required for abstraction volumes below 20m<sup>3</sup> per day.

3.2.5 Table 2 summarises surface water discharge consents within 500m of the route.

Table 2: Surface water discharge consents

Reference number	Permit identifier	Distance and direction from route (in metres)	Discharge type	Receiving water body
CFA5WD19	Canm.0163	80m (north)	Trade effluent discharge - site drainage	Into foul water system/lake
CFA5SWD42	Temp.0736	125m (south)	Sewage discharge - pumping station - water company	Twyford Abbey Ditch
CFA5SWD43	Temp.1416	230m (north)	Sewage discharge - pumping station - water company	River Brent
CFA5SWD5	CATM.2995	30m (north)	Trade effluent discharge - site drainage	River Brent
CFA5WD4	CNTM.1696	10m (north)	Trade effluent discharge - site drainage	River Brent
CFA5WD6	CNTM.2057	420m (north)	Sewage discharges - final/treated effluent - not water company	GUC

### 3.3 Groundwater

- 3.3.1 A summary of the geological units present in the Northolt Corridor area, together with their hydrogeological characteristics, is presented in Volume 2, CFA Report 5, Section 8.
- 3.3.2 Map WR-02-005 (Volume 5, Water Resources and Flood Risk Assessment Map Book) indicates the spatial distribution of the uppermost superficial and bedrock formations within the area. A schematic cross-section of the area with regard to geological strata, groundwater levels (where known) and the Proposed Scheme is presented in Figure 1.
- 3.3.3 Figure 2 presents the groundwater elevation contours in the Chalk aquifer for this study area and adjacent areas using data from January 2013<sup>7</sup>. It should be noted that the Chalk is confined so the apparent water level is a representation of the water level that would be observed if the Chalk was penetrated by a borehole. It is not indicative of groundwater being present in the London Clay Formation. Groundwater flow in the

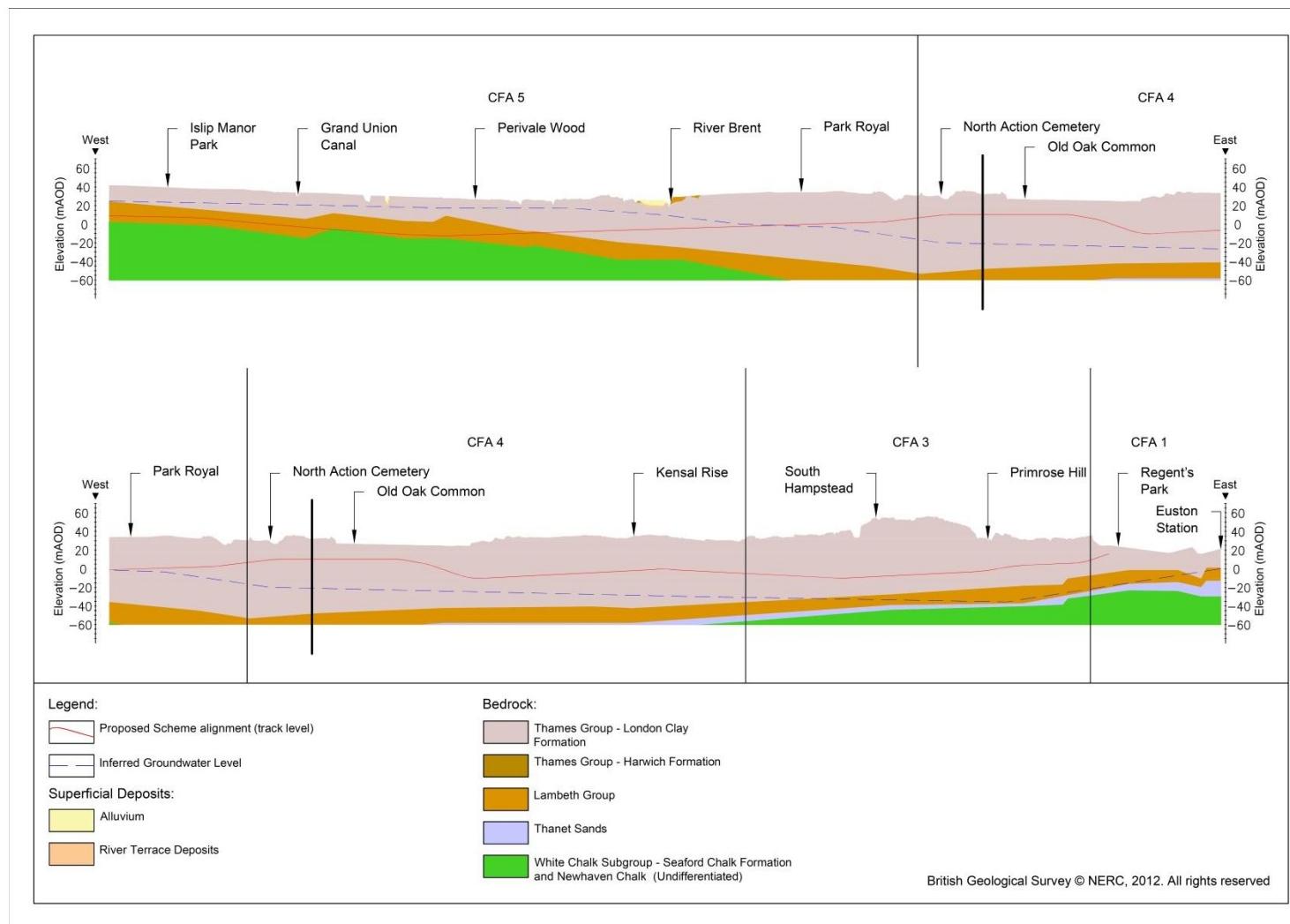
<sup>6</sup> Surface water abstractions for public supply are not included.

<sup>7</sup> Environment Agency (2013), *Management of the London Basin Chalk Aquifer Status Report 2013*

study area is towards the south-east as shown by the groundwater elevation contours in Figure 2.

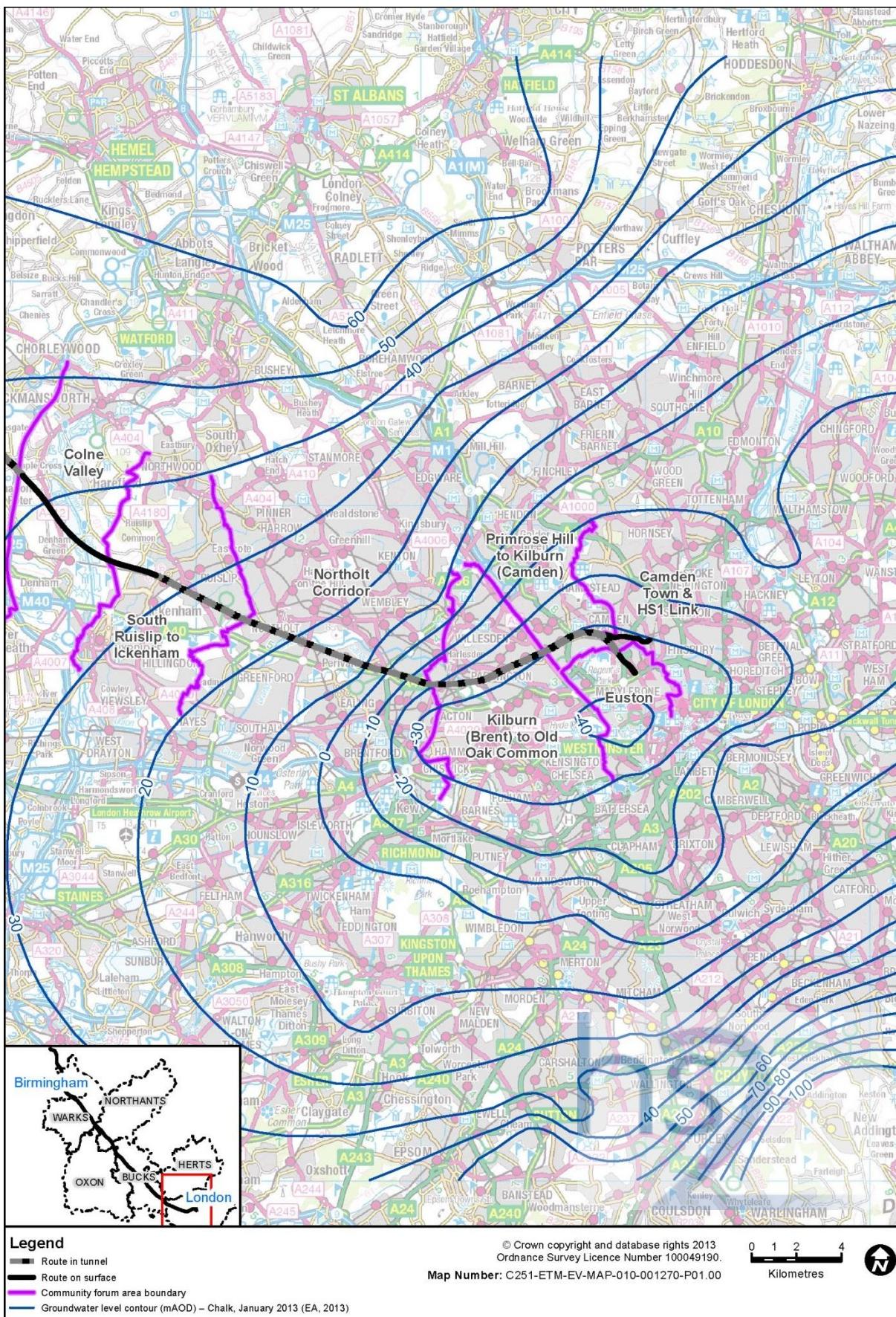
- 3.3.4 With the exception of the Thames Valley Formation, shallow groundwater within the superficial deposits is likely to be in continuity with surface water in the River Brent.
- 3.3.5 East of Bideford Avenue the Northolt tunnel will pass through the London Clay Formation. The London Clay Formation is designated as unproductive strata.

Figure 1: Schematic geological cross-section for CFA5



## Appendix WR-002-005

Figure 2: Groundwater elevation contours for this study area and the surrounding area



- 3.3.6 To the south-west of Park Royal (close to the Hangar Lane Gyratory), geological mapping shows the Claygate Member to be present. The Claygate Member is the uppermost unit of the London Clay Formation and comprises inter-bedded fine-grained sand, silt and clay.
- 3.3.7 West of Bideford Avenue the tunnel will pass into the Lambeth Group which is likely to be in hydraulic continuity with the underlying Thanet Sand Formation (where present) and the White Chalk Subgroup, part of the Chalk Principal aquifer.
- 3.3.8 At the eastern end of the study area, east of Park Royal, the route is expected to be above the groundwater level. To the west of Park Royal the route is expected to be below the groundwater level as shown in Figure 1.
- 3.3.9 Table 3 summarises licensed groundwater abstractions located within 1km of the route. There is the potential for further unlicensed abstractions to exist that have not been identified, as a licence is not required for abstraction volumes below 20m<sup>3</sup> per day.

Table 3: Licensed groundwater abstractions

Licence identifier (map reference number and Environment Agency reference)	Distance (and direction) from route (m)	Abstraction horizon	Maximum annual abstraction quantity (m <sup>3</sup> )	Maximum daily abstraction quantity (m <sup>3</sup> /d)	Purpose	Number of boreholes
<b>Public water supplies (PWS)</b>						
None in this area						
<b>Private abstractions</b>						
GW56 28/39/38/0050	145m (north-east)	Chalk	582912	2,304	Non-evaporative cooling	3
GW55 28/39/38/0050	130m (north-east)					
GW54 28/39/38/0050	105m (north-east)					
GW53 TH/039/0038/002	215m (north-east)	Chalk	2555	7	Domestic	1
GW52 TH/039/0038/002	215m (north-east)	Lambeth Group	40000	300	Spray irrigation	1
GW51 28/39/38/0049	415m (north-east)	Chalk	110376	302.4	Non-evaporative cooling	1
GW50 28/39/38/0047	970m (south-west)	Chalk	6000	100	Horticultural watering, municipal grounds	1
GW48 28/39/38/0048	920m (south-west)	Chalk	80000	480	Make-up or top up water, municipal grounds	1

- 3.3.10 No unlicensed groundwater abstractions have been identified within 1km of the route.
- 3.3.11 Table 4 summarises groundwater discharge consents to groundwater directly or via land, within 1km of the route.

Table 4: Discharge consents to groundwater

Reference number	Permit identifier	Distance and direction from route (m)	Discharge type	Receiving strata/water body
CFA5WD33	Canm.0879	25m (south)	Sewage discharges - final/treated effluent	Taplow Gravel Formation
CFA5WD34	Canm.0878	25m (south)	Sewage discharges - final/treated effluent	Taplow Gravel Formation
CFA5WD35	Npswqd003166	370m (north)	Trade discharges - cooling water	Assumed Chalk
CFA5WD49	Npswqd003873	40m (north)	Trade discharges - cooling water	Assumed Chalk

## 3.4 Surface water/groundwater interaction

- 3.4.1 Table 5 summarises the surface water/groundwater interactions within 1km of the route.

Table 5: Surface water/groundwater interaction

Location description	Distance (m) and direction from route	Formation	Approximate Elevation (metres above Ordnance Datum, m AOD)	Comments
River Brent SWC-CFA05-01	The route will pass beneath the river in tunnel.	Alluvium Taplow Gravel Formation	20	There could be shallow groundwater present within the Alluvium and Taplow Gravel Formation in the vicinity of the River Brent. It is considered likely that the surface water and groundwater are in hydraulic connectivity.  The Proposed Scheme is expected to have a negligible impact on the surface water/groundwater interaction.
River Brent WR-02-005, F6	The route will pass beneath the area of surface water/groundwater interaction, which is 50m south of the route at its closest point and extends beyond Ealing Golf Course.	Kempton Park Gravel Formation	20	There could be shallow groundwater present within the Kempton Park Gravel Formation in the vicinity of the River Brent. It is considered likely that the surface water and groundwater are in hydraulic connectivity.  The Proposed Scheme is expected to have a negligible impact on the surface water/groundwater interaction.

### 3.5 Water dependent habitats

3.5.1 There are no known water dependent habitats within 1km of the route in the area.

## 4 Site specific surface water assessment

### 4.1 Surface water

- 4.1.1 Table 6 summarises potential impacts and effects to surface water features from the Proposed Scheme in the study area. Only those impacts and effects that are classed as significant are presented in Volume 2, CFA Report 5, Section 13.4.
- 4.1.2 Table 6 only includes water features which could potentially be impacted by the Proposed Scheme. Features such as isolated ponds and drains which will lie outside the construction footprint and area of impact of the Proposed Scheme, i.e. up to 1km from the Proposed Scheme, are not included. Details of these features are provided in Table 1. Tunnel drainage is not referred in the table as the drainage will be discharged directly to Thames Water Utilities Ltd sewers in this CFA.
- 4.1.3 The draft Code of Construction Practice (CoCP) referred to in Table 6 sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme (see Volume 5: Appendix CT-003-000/1). These will provide effective management and control of the impacts during the construction period.

Table 6: Summary of potential impacts to surface water

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
<b>Water features</b>									
Park Royal several ponds and drains CFA05-P01	Moderate	Satellite construction compounds within Park Royal.  Westgate vent shaft	Potential surface water flow and quality effects.	Minor impact  Slight effect (Not significant)	The construction temporary impacts are addressed by the CoCP.	Negligible impact  Neutral effect (Not significant)	None	None	Not applicable
Hanger Hill Park drains WR-01-005, E6	Moderate	Westgate vent shaft	Potential surface water flow and quality effects.	Minor impact  Slight effect (Not significant)	The construction temporary impacts are addressed by the CoCP.	Negligible impact  Neutral effect (Not significant)	None	None	Not applicable
River Brent SWC-CFA05-01	High	Westgate vent shaft including construction compound located approximately 290m east of receptor.	Potential surface water flow and quality effects.	Minor impact  Moderate effect (Significant)	The construction temporary impacts are addressed by the CoCP.	Negligible impact  Neutral effect (Not significant)	None	None	Construction (temporary)
	High	Northolt tunnel and cross passages	Settlement caused by tunnelling activities. Asset protection work and any settlement monitoring may lead to polluting materials in run-off into the River Brent near the crossing  See Section 4.2	Negligible impact  Neutral effect (Not significant)	None required other than CoCP measures.	Negligible impact  Neutral effect (Not significant)	None	None	Construction (temporary)

Appendix WR-002-005

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Perivale Industrial Park culverted drain  SWC-CFA05-02	Moderate	Northolt tunnel and cross passages	Settlement caused by tunnelling activities.  See Section 4.2	Negligible impact  Neutral effect  (Not significant)	None required	Negligible impact  Neutral effect  (Not significant)	None	None	Not applicable
Horsenden Hill drains, culvert and 5 ponds  CFA05-P03	Moderate (drains)  Low (ponds)	Northolt tunnel construction compound  Greenpark Way vent shaft	Potential surface water flow and quality effects.	Minor impact  Slight effect  (Not significant)	The temporary construction impacts are addressed by the CoCP.	Negligible impact  Neutral effect  (Not significant)	None	None	Not applicable
Greenford Road culverted drain (Costons Brook)  SWC-CFA05-03	Moderate	Northolt tunnel and cross passages	Settlement caused by tunnelling activities.  See Section 4.2	Negligible impact  Neutral effect  (Not significant)	None required	Negligible impact  Neutral effect  (Not significant)	None	None	Not applicable
GUC (Paddington Branch)  SWC-CFA05-04	High	Northolt tunnel and cross passages	Settlement caused by tunnelling activities. . Asset protection work and any settlement monitoring may lead to polluting materials in run-off into the canal near the crossing  See Section 4.2 for details	Negligible impact  Neutral effect  (Not significant)	None required other than CoCP measures.	Negligible impact  Neutral effect  (Not significant)	None	None	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
	High	Mandeville Road vent shaft  Greenpark Way vent shaft  Main and satellite construction compounds	Potential surface water flow and quality effects.	Minor impact  Moderate effect (Significant)	The temporary construction impacts are addressed by the CoCP.	Negligible impact  Neutral effect (Not significant)	None	None	Construction (temporary)
GUC dock and drains  WR-01-005, H5	Moderate	Ecological mitigation planting	Potential surface water flow and quality effects.	Negligible impact  Neutral effect (Not significant)	None required	Negligible impact  Neutral effect (Not significant)	None	None	Not applicable
Belvue Park unnamed watercourse  WR-01-005, G7	Moderate	Northolt tunnel construction compound located approximately 275m north-east of receptor.  Mandeville Road vent shaft	Potential surface water flow and quality effects.	Minor impact  Slight effect (Not significant)	The temporary construction impacts are addressed by the CoCP.	Negligible impact  Neutral effect (Not significant)	None	None	Not applicable

## 4.2 Detailed assessments

- 4.2.1 The route is fully within bored tunnel in the area. The tunnel is routed under two open watercourses: the River Brent (Map WR-01-005, SWC-CFA05-01) and the Paddington Branch of the GUC (Map WR-01-006, SWC-CFA05-04). It will also pass beneath two minor drains that are in extended culverts: Perivale Park Brook (Map WR-01-005, SWC-CFA05-02) and Costons Brook (Map WR-01-005, SWC-CFA05-03). Information for the culverted drains is very limited but they are assumed to be running just below present ground level.
- 4.2.2 The River Brent and the GUC (Paddington Branch) are the only watercourses within this area with a WFD designation and status.
- 4.2.3 The distance between the top of the tunnel and the bed of the River Brent at crossing point SWC-CFA05-01 is 12m and the distance between the top of the tunnel and the bed of the GUC (Paddington Branch) at SWC-CFA05-04 is 23m. Given the impermeable nature of the London Clay Formation which covers the tunnel there is very little potential for the work to interfere with any surface water receptors and as such the impacts are assessed as negligible and the effects neutral.
- 4.2.4 Settlement at watercourse crossings as a result of tunnelling is predicted to be minor and very localised - the predicted contour for up to 10mm of settlement runs parallel to the tunnel less than 100m from the outer tunnel wall. Asset protection work and settlement monitoring will be undertaken at SWC-CFA05-01 for the existing railway bridges and associated hard river bank defences, and at SWC-CFA05-04 for the GUC banks. The asset protection measures will mitigate for the settlement so that the effect on these high value watercourses will be neutral.
- 4.2.5 Tunnel drainage arising from any ingress of surface water, accidental spills or fire water will be directed towards the Westgate, Greenpark Way and Mandeville Road vent shafts where it will be pumped to the surface and discharged as appropriate. It is anticipated that discharge will be through a connection to the Thames Water Utilities Ltd sewer network.

## 5 Site specific groundwater assessment

### 5.1 Summary of assessment

5.1.1 Table 7 summarises all the potential impacts to hydrogeology (groundwater), abstractions, surface water/groundwater interactions and water dependent habitats. Only those impacts and effects that are classed as significant are presented in Volume 2, CFA Report 5, Section 13.4.

Appendix WR-002-005

Table 7: Summary of potential impacts to groundwater receptors

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
<b>Hydrogeology (groundwater)</b>									
Chalk Principal Aquifer	High	Northolt tunnel, cross passages and vent shafts	Raised turbidity due to construction activities	Negligible impact Neutral effect (Not significant)	With implementation of the CoCP and best practice, there will be sufficient mitigation in place to avoid adversely impacting water quality.	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
Lambeth Group Secondary A aquifer  Thanet Sand Formation Secondary A aquifer	Moderate	Northolt tunnel, cross passages and vent shafts	Raised turbidity due to construction activities	Negligible impact Neutral effect (Not significant)	With implementation of the CoCP and best practice, there will be sufficient mitigation in place to avoid adversely impacting water quality.	Negligible impact Neutral effect (Not significant)	None	None	Not applicable
<b>Abstractions</b>									
GW56, GW55 and GW54 (28/39/38/0050)  GW52 (TH/039/0038/002)  GW51 (28/39/38/0049)	High	Northolt tunnel, cross passages and vent shafts	Raised turbidity due to construction activities.  The risk of turbidity affecting groundwater quality in the Chalk aquifer is low as the construction work will occur in the overlying London Clay and	Negligible impact Neutral effect (Not significant)	With implementation of the CoCP and best practice, there will be sufficient mitigation in place to avoid adversely impacting water quality.	Negligible impact Neutral effect (Not significant)	None	None	Not applicable

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
GW50 (28/39/38/0047)  GW48 (28/39/38/0048)			Lambeth Group.  In the unlikely event that groundwater quality is affected, this will not affect these abstractions, which are not used as potable supplies.  Refer to Section 5.2 for further details						
GW53 (TH/039/0038/002)	High	Northolt tunnel, cross passages and vent shafts	The risk of turbidity affecting groundwater quality in the Chalk aquifer is low as the construction work will occur in the overlying London Clay and Lambeth Group.  Notwithstanding this, in the unlikely event that groundwater quality is affected, the effect on this abstraction would be significant as it is used for domestic purposes and could be used as a potable supply.  Refer to Section 5.2 for further details	Moderate impact  Moderate effect  (Significant)	With implementation of Sections 12 and 16 of the draft CoCP mechanisms will be in place to avoid adversely impacting water quality through construction activities.  Although unlikely, where there is the potential for significant adverse effects on the licensed private water abstraction during construction, monitoring of groundwater turbidity will be used to verify if effects are occurring and provide evidence to justify further intervention, should that be required.	Moderate impact  Moderate effect  (Significant)	Should further mitigation be required, appropriate measures will be agreed with the owner in advance of construction commencing and may, for example, consist of the provision of a temporary alternative supply.	Negligible impact  Neutral effect  (Not significant)	Not applicable

## 5.2 Detailed assessment

### *Impact on groundwater abstractions from the Northolt tunnel*

5.2.1 There are eight private abstractions within 1km of the route as summarised in Table 8.

Table 8: List of private groundwater abstractions

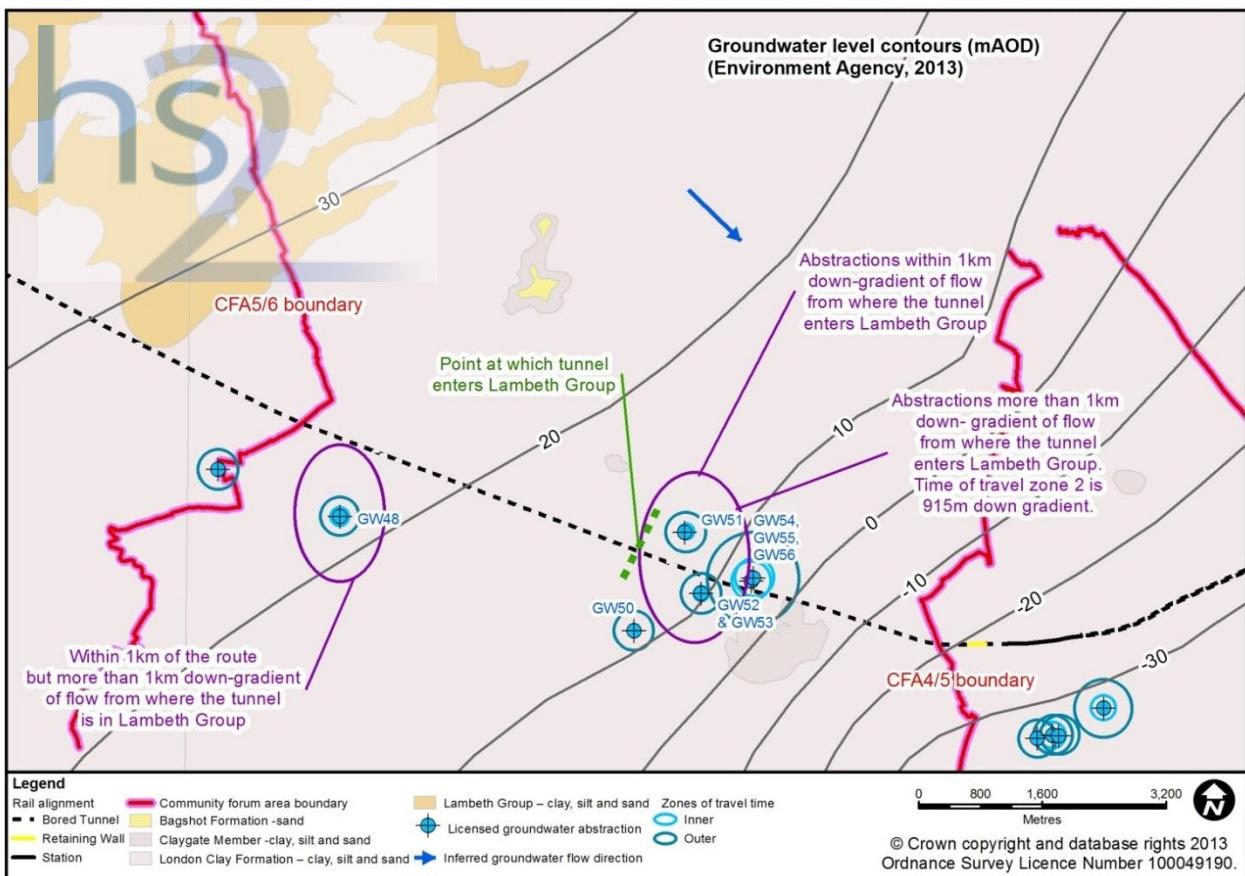
Abstraction reference	Design element	Time of travel zone 1 intersected by route?	Time of travel zone 2 intersected by route?	Use of abstraction
GW56	Northolt tunnel Cross passages Vent shafts	No	No - route is in the London Clay Formation	Non-evaporative cooling
GW55		No	No - route is in the London Clay Formation	Non-evaporative cooling
GW54		No	No - route is in the London Clay Formation	Non-evaporative cooling
GW53		No	No	Domestic
GW52		No	Yes	Spray irrigation
GW51		No	No	Non-evaporative cooling
GW50		No	No	Horticultural watering, municipal grounds
GW48		No	No	Make-up or top up water, municipal grounds

5.2.2 Construction of the tunnel, cross passages and vent shafts to the west of Bideford Avenue would be within the Lambeth Group aquifer. Although these excavations are unlikely to extend through the base of the Lambeth Group into the Chalk they could be very close to the boundary between the base of the Lambeth Group and the top of the Chalk. The publicly available borehole records indicate that the Thanet Sand Formation is absent in this part of the area. Groundwater in the Lambeth Group may be hydraulically connected with groundwater in the underlying Thanet Sand Formation (where present) and Chalk aquifer.

5.2.3 The Chalk is designated as a Principal aquifer and is, therefore, considered to be a high value receptor. Data available from the Environment Agency (2013)<sup>8</sup> and the groundwater level information shown in Figure 2 indicate groundwater flow within the Chalk to be towards the south-east. In the event that construction activities cause increased turbidity within the Lambeth Group aquifer a degree of filtration and attenuation would take place in the sandier strata at the base of the Lambeth Group. If there are areas where the top of the Chalk is found to be higher than shown in Figure 3 construction could take place within the Chalk itself. There is therefore some potential for raised turbidity and an effect on groundwater quality in the Chalk aquifer.

<sup>8</sup> Environment Agency (2013), *Management of the London Basin Chalk Aquifer Status Report 2013*

Figure 3: Illustration of abstraction locations relative to the route and geology



- 5.2.4 Three licensed groundwater abstractions (Map WR-02-005, GW56, GW55 and GW54 - see Table 7 for licence numbers) are located within 200m of the route where it is in the London Clay Formation (see Figure 3). The time of travel zone 2 for these abstractions is, however, 915m down-gradient from where the tunnel penetrates the Lambeth Group. The majority of the route will be within the London Clay Formation within 1km of these abstractions and there will be sufficient dilution of any impacts to groundwater quality in the Lambeth Group up-gradient. There is therefore considered to be a neutral impact and negligible, effect on the groundwater quality that is not considered to be significant.
- 5.2.5 Five abstractions (Map WR-02-005, GW53, GW52, GW51, GW50 and GW48 - see Table 7 for licence numbers) are between 200m and 1km of the route. The time of travel zone for GW50 does not intersect the route and so there will be a neutral impact. The remaining four abstractions (GW48, GW51, GW52 and GW53) are within 1km of the length of the route expected to be in the Lambeth Group (Figure 3).
- 5.2.6 GW48 is within 1km of the route but more than 1km down-gradient from where the tunnel will be in the Lambeth Group. The time of travel zone 2 is not crossed by the route. As a result there will be no significant effect to groundwater quality at this abstraction.
- 5.2.7 GW51, GW52 and GW53 and their time of travel zone 2 are within 1km down-gradient from where the tunnel penetrates below the London Clay Formation into the

Lambeth Group and there is therefore potential for minor increases in turbidity. It is also likely, however, that the available thickness of Lambeth Group would act as a filter to any groundwater moving through it and any turbidity rises at the abstractions would be small.

- 5.2.8 Abstraction GW53 is the only location where the data available indicate that groundwater is used for domestic purposes and would therefore be sensitive to changes in turbidity. The assessment shows it is unlikely that groundwater quality at this location will be significantly affected due to the distance of this abstraction from the point at which the tunnel would penetrate the Lambeth Group.

## 6 References

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- Centre for Ecology and Hydrology, (2009) Flood Estimation Handbook (FEH) CD-Rom Version 3.0
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- Land Drainage Act* (1991), London, Her Majesty's Stationery Office.
- Water Framework Directive - *Directive 200/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Strasbourg, European Parliament and European Council*
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